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MODAL AND FREQUENCY ANALYSIS OF BEARING-TYPE TRANSFERRING FIXED ON THE FRAME AT THE BOTTOM

MODÁLNA A FREKVENČNÁ ANALÝZA TRANSFERINGU LOŽISKOVÉHO TYPU UPEVNENÉHO NA RÁM ZO SPODU

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Abstract

A building line is a common type of equipment used in the rubber-processing industry to build radial truck tyres in the semi-automatic production mode. The bearing-type transferring is part of the equipment. The paper presents modal and frequency analysis of the bearing-type transferring fixed on the frame at the bottom with the help of the mathematic modelling of finite element method with utilization of Pro-Engineering and Cosmos M. The paper also presents results of the stress analysis of the transferring.

Abstrakt

Jedným zo zariadení pre gumárenský priemysel je konfekčná linka, určená pre štandardnú konfekciu nákladných radiálnych plášťov v poloautomatickom režime, ktorej súčasťou je i transfering ložiskového typu. Príspevok sa zaoberá modálnou a frekvenčnou analýzou transferingu ložiskového typu pri jeho upevnený na rám zo spodu s pomocou matematického modelovania konečných prvkov s využitím programu Pro-Inžinier a Cosmos M. V príspevku sú tiež výsledky napäťovej analýzy uvedeného transferingu.

Key words: building line, transferring, bearing-type, mathematic modelling

1. Introduction

The main production programme in Matador Machinery, a. s. are facilities for the rubber industry which compose 75% of the production in present. It includes also production line for the production of the truck tyres, light-weight tyres and tyres. The line is dedicated for the standard production of the ALL STEEL radial truck tyres 17,5", 19,5", 20", 24", 24,5" in semiautomatic mode. The production line NR3 (Fig. 1).achieves daily till 300 pieces of tyres with two operators. It contains bearing-type transferring, attached to the frame from above (Fig. 2).

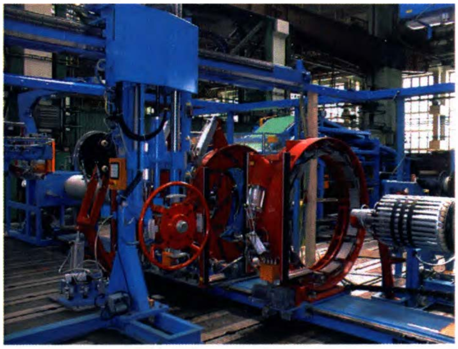


Fig. 1 The production line NR3

Transferring was designed in program Pro/Engineer and then exported like *.igs to the program COSMOS M for the creation of the finite-element model. The static and dynamic calculation was made for the loading with reference to the weight functioning in individual centers. The weight of the individual entities is: entity cast with the cylinders – 137 kg, upper convection – 33 kg, lower convection – 10 kg, grips – 64 kg, cylinders – 30 kg and maximal velocity of the cart motion $v_{max} = 1$ m/s.

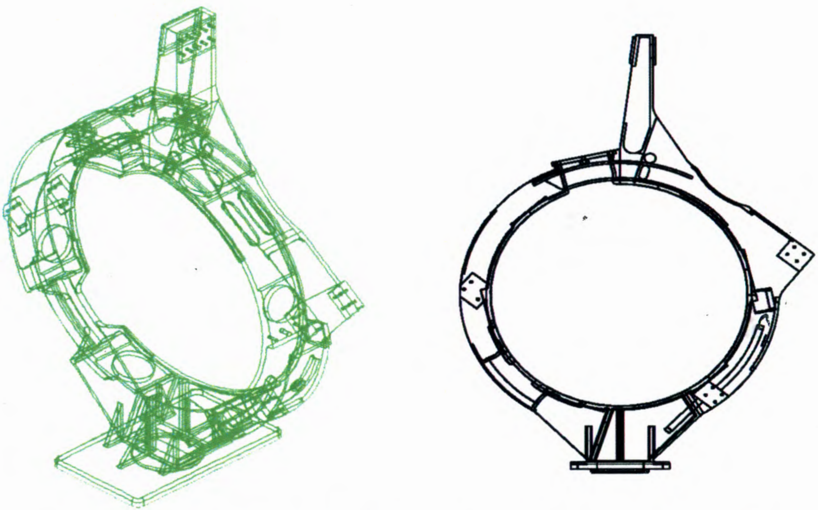


Fig. 2 Bearing-type transferring, attached to the frame from above

2. The calculation of the natural frequencies and natural shapes transferring

Mathematical model is in known in form (1)

$$[\mathbf{M}]\{\ddot{\mathbf{u}}\}+[\mathbf{C}]\{\dot{\mathbf{u}}\}+[\mathbf{K}]\{\mathbf{u}\}=\{\mathbf{f}(\mathrm{t})\} \tag{1}$$

where **M** is the mass matrix, **C** is the damping matrix, **K** is the stiffness matrix, $\{\mathbf{f}(\mathrm{t})\}$ is the time varying load vector and $\{\mathbf{u}\}$, $\{\dot{\mathbf{u}}\}$, $\{\ddot{\mathbf{u}}\}$ are the displacement, velocity and acceleration vectors, respectively.

Modal and frequency analysis were done according to known equation in the form

$$\left(-\omega_i^2[\mathbf{M}]+[\mathbf{K}]\right)\cdot\{\Phi_i\}=\{0\} \tag{2}$$

where ω_i is i-th natural frequency, $\{\Phi_i\}$ is the eigenvector representing the nodal shape of i-th natural frequency.

We calculated natural frequencies and from the natural frequencies were calculated frequency characteristics with the modal damping $\xi = 0{,}001$.

The motion equation for the i-th eigenshape is in accordance with:

$$\ddot{x}_i + 2\xi_i\omega_i\dot{x}_i + \omega_i^2 x_i = \{\Phi\}_i^T\{f\} \tag{3}$$

This relationship is generalized problem of the natural values which solution is made by the semi-automatic-space iterative method. This method is based on the idea of the inverse iteration conversion with several vectors at the same time.

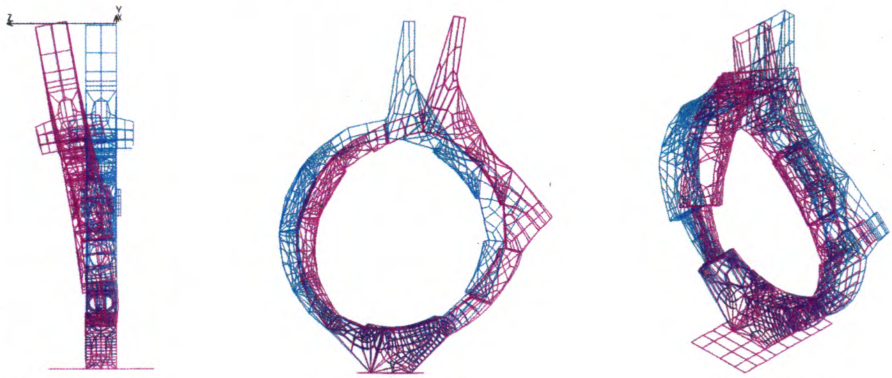
At fig. 3 we can see first three natural frequencies calculated by the help of the underspace method.

The frequency characteristics were counted for the separate points with exciting force (with amplitude 1 N). The frequency characteristic for nodal point No. 250 is on the **fig. 4**. For Rayleigh damping in the form

$$\mathbf{C} = \alpha\mathbf{M} \tag{4}$$

We consider the material damping of $\alpha = 0{,}001$.

On the Fig. 3 are described the first three natural shapes of vibrations.



F_Mode=1	F_Mode=2	F_Mode=3
0.617244 Hz	0.915527 Hz	1.62308 Hz

Fig. 3 First three natural shapes of vibrations

The frequency characteristic for nodal point No. 250 is on the Fig.4.

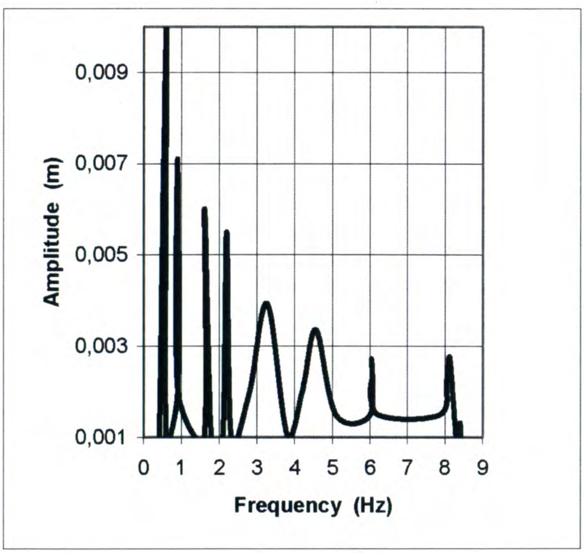


Fig. 4 Amplitude-frequency characteristic for the nodal point No. 250

3. Calculation of the transferring construction loading by the static loading

Transferring's mathematical model was created with fournodal thin shell elements. Stability equations are solved (5):

$$[\mathbf{K}]\{\mathbf{u}\} = \{\mathbf{f}(t)\} \tag{5}$$

Static analyse of the transferring construction includes solution of the stability equations (5) distribution [MPa]. The transferring computing model is on the Fig. 5 and tenseness distribution is on the Fig. 6 in [MPa].

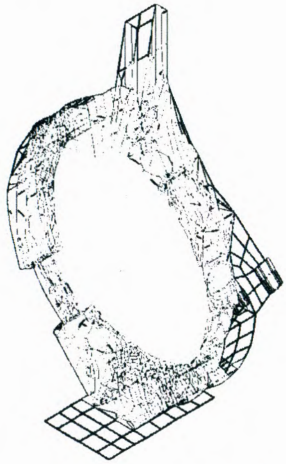


Fig. 5 Transferring computing model

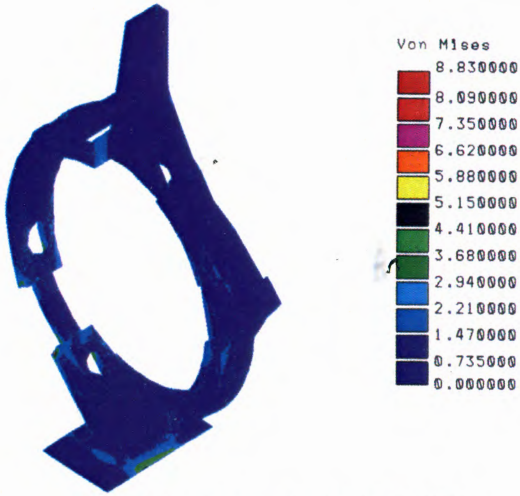


Fig. 6 Tenseness distribution [MPa]

4. Conclusion

Transferring is made of aluminium alloy and it is suitable that it works with sufficient high safety margin.The frequency analyse results, that the first three vibrating shapes can affect transferring work session.

Acknowledgement

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